PREVALENCE OF *CAMPYLOBACTER* AND *SALMONELLA* IN THE CECAL DROPPINGS OF TURKEYS DURING PRODUCTION

N. A. COX[1], N. J. STERN, S. E. CRAVEN, M. E. BERRANG, and M. T. MUSGROVE
USDA, Agricultural Research Service, Russell Research Center
Box 5677, Athens, GA 30604-5677
Phone: (706) 546-3484
Fax: (706) 546-3771
e-mail: ncox@ars.usda.gov

Primary Audience: Researchers, Quality Assurance Personnel

SUMMARY

Cecal droppings from four commercial turkey flocks (two flocks of hens and two flocks of toms) were analyzed for the presence of naturally occurring salmonellae at ages 6, 10, and 15 weeks and for the presence of *Campylobacter* spp. at ages 3, 6, 10, and 15 weeks. The salmonellae contamination rates in these turkey flocks appeared to be somewhat different from that observed in broiler production. With broilers, salmonellae contamination in cecal droppings typically peaks at about 3 weeks of age and then steadily declines to almost zero prior to processing. In this study, the presence of salmonellae remained through grow-out (40% in toms and 13% in hens at 15 weeks of age). *Campylobacter* was maintained in a high percentage of turkey cecal droppings though production (77% in toms and 80% in hens at 15 weeks of age), which is similar to the trend observed for broilers. For *Campylobacter* and salmonellae, the percentage of positive droppings was slightly higher for toms than for hens. Overall, a higher percentage of commercial turkeys, regardless of sex, had *Campylobacter* in their ceca and intestinal tract as opposed to salmonellae. For toms, 80% were *Campylobacter* positive, and only 31.1% were salmonellae positive. For hens, 70% were *Campylobacter* positive, and only 17.7% were salmonellae positive.

Key words: *Campylobacter*, feces, *Salmonella*, turkey

2000 J. Appl. Poultry Res. 9:542–545

DESCRIPTION OF PROBLEM

Salmonella spp. and *Campylobacter* spp. have both been established as major causes of infectious enteritis in man. Poultry-borne transmission of these bacteria has been implicated as one route of infection. *Campylobacter* and salmonellae have been isolated from turkey and turkey products. *Campylobacter* was isolated from 11 of 12 (92%) turkey carcasses after processing and chilling [1]. In another study, 33 fully processed turkey carcasses were sampled, and 94% were found to be *Campylobacter* positive. In that study, more than 600 cecal cultures, 30 cloacal swabs, and 30 fresh feces samples were tested, and all of the samples were positive for *Campylobacter* [2]. In a 1983 study, isolations of *Campylobacter* were made from two different turkey processing plants [3]. At plant A, 86.7% of ceca and 61% of the final carcass rinse were *Campylobacter* positive. At Plant B, 93.3% of the ceca and 27.8% of the final carcass rinse were *Campylobacter*

[1] To whom correspondence should be addressed

positive. From both plants, the log count of *Campylobacter* per gram of feces ranged from 3.4 to 6.8, the mean was log 5 [3]. Also in 1983, Rayes *et al*. [4] reported that they isolated *Campylobacter* from 64.1% of 184 fresh turkey wings and from 55.6% of 81 frozen turkey wings. A year-long study (August 1996 through July 1997) of *Campylobacter* contamination of turkey was done by Food Safety Inspection Service of the USDA [5]. In that study, 1,221 rinse fluid samples were collected from 50 USDA-inspected turkey plants, and 90.3% was positive for *Campylobacter*; 18.6% was positive for salmonellae. In 1973, Nivas *et al*. [6] surveyed three turkey processing plants in Minnesota. They reported that the percentage of salmonellae-positive turkey carcass rinses gradually increased throughout the day: early morning, 11.7%; late morning, 22.2%; and early afternoon, 31.3%. Similar observations of increasing percentages of positive *Salmonella* samples from carcasses during the day in a chicken plant were reported [7]. Morgan-Jones [8] did not find salmonellae in eight samples of neck skin from processed turkeys; however, they did isolate salmonellae from water troughs, litter, and dust samples at the farm. Campbell *et al*. [9] sampled 109 eviscerated turkeys from salmonellae-free turkey flocks and reported that <1% of the samples was positive, but 6.3% of the 79 eviscerated turkeys from the salmonellae-positive flocks was found to be salmonellae positive.

As a nation, the United States is a large consumer of turkeys; almost 400 million are consumed each year. Research directed at assessing the carriage rate and reducing both the incidence and levels of various bacteria (such as *Campylobacter* and salmonellae) in turkey and turkey products should reduce human exposure, suffering, and economic costs associated with foodborne illness. The objectives of this study were to sample the cecal droppings of commercial male and female meat turkeys throughout production for the presence of both *Campylobacter* and salmonellae.

Materials and Methods

TURKEYS

All birds housed at the farms used in each replication of this study were of the same cross and were hatched on the same day in the same commercial hatchery. One farm was used to raise the male turkeys (toms), and the other was used to raise the females (hens). Both farms were on the same feed formulation and used separate house brooding. Each house was started with new (unused) pine shaving litter. All birds were driven (walked) from brooder house to the grow-out house between the 6-week sampling and the 10-week sampling. Toms were allowed access to an outside pen; hens were kept inside for the duration of the study. Two replications were completed at the same farms; each replication involved a new flock.

CAMPYLOBACTER

All samples were gathered from four commercial turkey flocks at 3 and 6 weeks of age (brooder house) and at 10 and 15 weeks of age (grow-out house). Fifteen fresh cecal droppings were collected starting at 8 a.m. on each sample day from each flock. Sterile rayon-tipped applicators were used to gather a part of each dropping. The swabs were placed into Cary-Blair transport medium [10], packed in ice, and transported to the laboratory. The swabs were placed in 9 ml saline. From this, 0.1 ml broth was placed on Campy-Cefex [11] agar plates and spread over the surface with a sterile plastic inoculating loop. These plates are then incubated in controlled atmosphere of 5% O_2, 10% CO_2, and 85% N_2 for 24 hr at 42 °C. Characteristic colony-forming units appearing on these plates were confirmed as *Campylobacter* spp. by observation of cellular morphology and motility on a wet mount using phase-contrast microscopy. Further confirmation was done by using the serological latex agglutination test to indicate that the isolate was a member of the *jejuni*, *coli*, or *lari* spp. [12].

SALMONELLA

All samples were gathered from the same commercial turkey flocks used for *Campylobacter* sampling. *Salmonella* samples were collected at 6 weeks of age (brooder house) and 10 and 15 weeks of age (grow-out house). Fifteen cecal droppings were collected starting at 8 a.m. on each sample day. Sterile rayon-tipped applicators were used to gather part of each dropping. The swabs were placed into Cary-Blair transport medium [11], packed in ice, and transported to the laboratory. At the laboratory, all of the swabs

TABLE 1. Number of salmonellae and *Campylobacter* positive cecal droppings from commercially housed turkey flocks

	TOMS		HENS	
AGE[A]	*Campylobacter*	Salmonellae	*Campylobacter*	Salmonellae
3	12[B], 15[C] (90%)	ND	15, 7 (73%)	ND
6	15, 8 (77%)	0, 6 (20%)	9, 10 (63%)	1, 8 (30%)
10	15, 8 (77%)	6, 4 (33%)	9, 10 (63%)	3, 0 (10%)
15	9, 14 (77%)	5, 7 (33%)	12, 12 (80%)	3, 1 (13%)

[A]Age in weeks.
[B]Number positive of 15 tested, replication one.
[C]Number positive of 15 tested, replication two.

were pre-enriched in universal pre-enrichment broth [11] for 24 hr at 35 °C [13]. Following incubation, 0.1 ml universal pre-enrichment was transferred to TT Hajna broth [11], which was incubated at 42 °C for 24 hr. Two loopfuls of TT Hanja broth were streaked onto brilliant green (BG) sulfa agar [11] and modified lysine iron agar plates [14] that were, in turn, incubated at 35 °C for 24 hr. Atypical coliform colonies were picked and transferred to triple sugar iron agar and lysine iron agar [11] slants. The slants were incubated for 24 hr at 35 °C. Cultures giving typical reactions on slants were confirmed as *Salmonella* with Poly O and Poly H serology [11].

Results and Discussion

Table 1 shows the *Campylobacter* isolations from turkey cecal droppings during production of toms and hens. Toms were not significantly more positive than hens (80% overall vs. 70%; $p > 0.05$) [15]. For toms, there was a 10% variation from one flock (replication) to the next [85% (Flock 1) and 75% (Flock 2)]. Hens also showed only a 10% variation from one flock to the next [75% (Flock 1) vs. 65% (Flock 2)]. The percentage of positive *Campylobacter* carriage remained fairly high throughout production (from Week 3 to Week 15) for both toms and hens.

Overall, the salmonellae carriage of commercial turkeys (Table 1) was much less ($p < 0.01$) [15] than the overall percentage of *Campylobacter* carriage observed. However, toms were slightly more likely to be positive for salmonellae than hens ($p < 0.05$) [15] (31 vs. 18%). With tom flocks, no significant difference ($p > 0.05$) [15] was found from flock to the next [24% (Flock 1) and 38% (Flock 2)]. Similarly, for hens there was no difference ($p > 0.05$) [15] between Flock 1 and Flock 2 [20% (Flock 1) and 15% (Flock 2)]. For toms and hens, the salmonellae contamination was low and a bit erratic, ranging from 10 to 40%, throughout production. This result differs from the frequency commonly observed in broilers, which is low incidence at the beginning of production, high occurrence in the middle of production, and reduced frequency at the end of production [16].

The results of this study showed that turkeys, similar to broilers, are contaminated with *Campylobacter* and *Salmonella* during the growing period. Farm contamination is likely carried into the processing plant because processed turkey carcasses can be contaminated with *Campylobacter* and *Salmonella* [2]. Effective on-farm intervention strategies should be applied to help reduce the contamination of the processed carcasses with these two important food-borne pathogens [17]. Breeder flocks and hatcheries are early critical sources of *Salmonella* in chicken [18] and turkeys [19, 20]. Competitive exclusion has been shown to reduce *Salmonella* effectively in chicken [7, 21] and turkeys [22]. Aggressive chemical treatment of the freshly laid fertile egg can reduce the presence of *Salmonella* in hatcheries [23]. Recent findings have shown that *Campylobacter*, similar to *Salmonella*, passes from the broiler breeder hen to her offspring through the fertile egg [24]. It is likely that the same situation exists with turkeys, and, therefore, the breeder flocks and hatcheries are key areas on which to focus to intervene in the *Salmonella* and *Campylobacter* contamination of commercial turkeys.

CONCLUSIONS AND APPLICATIONS

1. A higher percentage of turkeys (toms and hens) had *Campylobacter* in their droppings than salmonellae.
2. There was very little variation from Flock 1 and Flock 2 for toms and hens for both *Campylobacter* and salmonellae carriage.
3. Overall, toms were 80% positive for *Campylobacter* and 31.1% positive for salmonellae; hens were 70% positive for *Campylobacter* and 17.7% positive for salmonellae.
4. Effective on-farm intervention strategies must be applied to reduce contamination of turkeys by these two important food-borne pathogens.

REFERENCES AND NOTES

1. **Simmons, N.A. and F.J. Gibbs,** 1979. *Campylobacter* spp. in oven-ready poultry. J. Infect. 1:159–162.

2. **Leuchtefeld, N.W. and W.L. Wong,** 1981. *Campylobacter fetus* subsp. *jejuni* in a turkey processing plant. J. Clin. Microbiol. 13:266–268.

3. **Yusufu, H.I., C. Genigeorgis, T.B. Farver, and J.M. Wempe,** 1983. Prevalence of *Campylobacter jejuni* at different sampling sites in two California turkey processing plants. J. Food Prot. 46:868–872.

4. **Rayes, H.M., C. Genigeorgis, and T.B. Farve,** 1983. Prevalence of *Campylobacter jejuni* on turkey wings at the supermarket level. J. Food Prot. 46:292–294.

5. **USDA-FSIS,** 1998. Nationwide Young Turkey Microbiological Baseline Data Collection Program. Collection dates Aug. 1996–Jul. 1997.

6. **Nivas, S.C., M.C. Kumar, M.D. York, and B.S. Pomeroy,** 1973. *Salmonella* recovery from three turkey-processing plants in Minnesota. Avian Dis. 17:605–616.

7. **Blankenship, L.C., J.S. Bailey, N.A. Cox, N.J. Stern, R. Brewer, and O. Williams,** 1993. Two-step mucosal competitive exclusion flora treatment to diminish salmonellae in commercial broiler chickens. Poult. Sci. 72:1667–1672.

8. **Morgan-Jones, S.C.,** 1982. The presence of salmonellae during the rearing of turkeys. Br. Poult. Sci. 23:481–486.

9. **Campbell, D.F., R.W. Johnston, M.W. Wheeler, K.V. Nagaraja, C.D. Szymansaki, and B.S. Pomeroy,** 1984. Effects of the evisceration and cooling processes on the incidence of *Salmonella* in fresh dressed turkeys grown under *Salmonella*-controlled and uncontrolled environments. Poult. Sci. 63:1069–1072.

10. Difco Laboratories, Division of Becton Dickinson and Company, Sparks, MD 21152.

11. **Stern, N.J. and J.E. Line,** 1992. Comparison of three methods for recovery of Campylobacter spp. from broiler carcasses. J. Food Prot. 55:663–666.

12. INDX, Integrated Diagnostics, Inc., 1756 Sulphur Spring Rd., Baltimore, MD 21227.

13. **Bailey, J.S. and N.A. Cox,** 1992. Universal preenrichment broth for the simultaneous detection of *Salmonella* and *Listeria* in foods. J. Food Prot. 55:256–259.

14. **Bailey, J.S., J.Y. Chiu, N.A. Cox, and R.W. Johnston,** 1988. Improved selective procedure for detection of salmonellae from poultry and sausage products. J. Food Prot. 51:391–396.

15. Comparisons of the prevalence of *Campylobacter* spp. or *Salmonella* in cecal droppings were performed using Chi-square test for independence.

16. **Linton, A.H. and M.H. Hinton,** 1988. Enterobacteriaceae associated with animals in health and disease. Symp. Ser. Soc. Appl. Bacteriol. 17:71s–85s.

17. **Cox, N.A., N.J. Stern, and J.S. Bailey,** 1999. Sources of *Salmonella* and *Campylobacter* in poultry and methods to intervene. Pages 5–7 In: Proc. 52nd Annual Reciprocal Meat Conference, Stillwater, OK.

18. **Cox, N.A.,** 1998. Incidence and impact of salmonellae in broiler hatcheries. Pages 88–92 In: International Symposium on Food-Borne Salmonella in Poultry, Baltimore, MD.

19. **Cox, N.A., N.J. Stern, J.S. Bailey, and M.E. Berrang,** 1998. Prevalence of *Salmonella* in the cecal droppings of turkeys during production. Poultry Sci. 77(Suppl. 1):114. (Abstr.).

20. **Cox, N.A., N.J. Stern, M.T. Musgrove, and M.E. Berrang,** 1998. Prevalence of *Campylobacter* in the cecal droppings of turkeys during production. Poult. Science 77(Suppl. 1):113. (Abstr.).

21. **Goren, E., W.A. de Jong, P. Doornenbal, N.M. Bolder, R.W. Mulder, and A. Jansen,** 1988. Reduction of salmonella infection of broilers by spray application of intestinal microflora: a longitudinal study. Vet. Q. 10:249–255.

22. **Bailey, J.S., N.A. Cox, and N.J. Stern,** 1996. Effect of turkey husbandry practices on the efficacy of mucosal competitive exclusion treatment to control salmonellae. Poult. Sci. 75(Suppl. 1):102. (Abstr.).

23. **Cox, N.A., J.S. Bailey, M.E. Berrang, and J.M. Mauldin,** 1997. Diminishing incidence and level of salmonellae in commercial broiler hatcheries. J. Appl. Poult. Res. 6:90–93.

24. **Cox, N.A., N.J. Stern, K.L. Hiett, and M.E. Berrang,** 1999. Transmission of *Campylobacter jejuni* from breeders to commercial broiler chickens. Page 67 In: Proc. 10th International Workshop on CHRO, Baltimore, MD.

ACKNOWLEDGMENTS

Outstanding technical assistance was received from D. Posey and Susan Brooks.